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# I. On the Distribution and Composition of the Humus of the Loess Soils of the Transition Region

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# I.—ON THE DISTRIBUTION AND COMPOSITION OF THE HUMUS OF THE LOESS SOILS OF THE TRANSITION REGION

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## INTRODUCTION

The main object of this investigation has been to determine the distribution of the humus, to a depth of six feet, throughout the soils in representative virgin prairies of the so-called "transition region" of Nebraska. This region is the large area which extends westward from the Missouri River for a distance of over three hundred miles and which is covered, for the most part, with loess soil. This is, agriculturally, the most important soil in the state of Nebraska, and covers more than half the area of the state. The term "transition region" is employed to convey the idea of a gradual transition from a semi-arid condition, in the western part of the loess area, to a humid condition in the eastern part.

The term "humus" in this thesis is used to represent the humified organic matter in the soil, which is soluble in dilute alkalies. By the term "soil" is meant all soil through a depth of six feet, no line being drawn between surface-soil and subsoil.

The ratio of humus to total nitrogen was determined in the case of all soils of the first and second feet, while in all first-foot soils the nitrogen content of the humus was determined.

Considerable work, also, was done during the course of this research, with a view to determining which are the most satisfactory and practical methods for the determination of the above-mentioned soil-constituents, under different conditions.

## METHODS USED IN THE DETERMINATION OF HUMUS, NITROGEN AND HUMUS NITROGEN

Before beginning the investigation of the humus and humus nitrogen content of the soils of the Transition Region, taken at various depths, it was necessary to select methods which would give reliable results, as well as be reasonably economical of time. Before finally selecting a method for the gravimetric determination of humus, three methods were taken into consideration, viz., the "Official" method, which is the method of the Association of Official Agricultural Chemists of the United States, the method devised and used by Hilgard, and the method worked out by Rather, which is a modification of the "Official" method. Some surface soil from the Nebraska Experiment Station farm was taken as a standard and this was used in all cases. The "Official" method was discarded after a very brief trial, as it was found, as had been previously reported by others, to give results which are unreliable; it has been proven on numerous occasions that the results obtained by the "Official" method are very high, often several times as high as the results obtained by a "Hilgard" determination on the same soil, the latter method having been generally accepted as one which gives reasonably accurate and dependable results.

### THE OFFICIAL METHOD

The "Official" method is carried on as follows: The soil sample, usually 10 grams, is placed in a filter and washed repeatedly with 1 per cent. hydrochloric acid until the washings show no precipitate when treated with ammonium hydrate and ammonium oxalate. This treatment extracts all lime and magnesia, which, if present, would prevent the humus going into solution in the later treatment with 4 per cent. ammonium hydroxid. The acid is then removed by repeated washings with distilled water, using silver nitrate or litmus paper to test the final washings. The soil is then transferred to a container with 500 c.c. of 4 per cent. ammonium hydroxid, and allowed to remain, with occasional shaking, for 24 hours. The suspended matter is allowed 12 hours more in which to settle, after which the supernatant liquid is drawn off and filtered, and an aliquot of this is evaporated to dryness in a tared platinum or quartz dish. The residue is then dried, either from 12 to 24 hours at 100° C. or from 2 to 4 hours at 110° C., and weighed. It is then ignited and weighed again. The difference in weight after ignition represents the weight of humus, while the difference between the first weight of the dish and the final weighing represents the so-called humus ash. The source of error in this method is the considerable amount of very finely divided clay which remains in suspension even after filtration. Accordingly when the residue obtained by the evaporation of the solution is ignited, this clay is dehydrated, and the difference in weight, caused by this loss of water, is recorded as humus, while the aluminum silicate remaining is weighed up as humus ash. Accordingly, it is obvious that as far as humus alone is concerned, this method is inaccurate and unreliable, and for this reason it is now commonly accepted as unreliable.

### THE HILGARD METHOD

The Hilgard method is generally accepted as being more reliable than the "Official" method, although it is much longer and more tedious, often involving ten to twenty days. In this process the lime and magnesia are extracted in the same manner as in the "Official" method, but the extraction with the 4 per cent. ammonium hydroxide is carried on in a different manner. After the extraction of lime and magnesia, the soil is treated on the filter with 4 per cent. ammonium hydroxide, and this treatment is carried on either continuously or at intervals, until the liquid comes through practically colorless, on which the extraction of humus is assumed to be complete. This method not only frequently takes several days, but often a very large amount of humus solution is obtained and a correspondingly large amount of it must be used in the evaporation, which is then carried out as in the

"Official" method. In most cases a slight amount of finely-divided clay is carried through the filter in this method, also, but the amount is so slight that the error caused by it is negligible, being less than the experimental error. As stated above, however, the method is accurate and its results may be relied upon when it has been performed correctly.

### THE RATHER METHOD

The "Rather" method, however, was found to be more satisfactory than either of the other two, especially where a large number of gravimetric determinations are to be made, since it combines the speed of the "Official" method with the accuracy of the "Hilgard" method. The "Rather" method, as named after the man who proposed it, is a modification of the "Official" method, and was originally described in the *Journal of Industrial and Engineering Chemistry*[1] as follows:

"Prepare humus solution as described in the 'Official' method, and dissolve 0.65 gr. of ammonium carbonate in 130 c.c. of the solution. Allow to stand over night in a glass-stoppered cylinder to allow the clay to settle, and decant the clear supernatant liquid thru a dry filter into a dry flask. Evaporate 100 c.c. of the filtrate in a tared platinum dish, dry for three hours at 100°, weigh, ignite and weigh again. Record loss on ignition as humus." This method gave results concordant with those of the Hilgard method, and in view of this, together with the fact that it required much less time and attention, it was adopted for all the gravimetric determinations given below. The success of this method is due to the fact that the finely-divided clay is flocculated by the ammonum carbonate and held by the filter. Because of this flocculation of clay one might expect a lowering of the percentage of the so-called "humus ash," and this is actually the case, as this method gave a lower percentage of humus ash than did any other.

### THE BLISH METHOD

Still another method suggested itself during the course of the work, and this may be referred to as the "Blish method." This

[1] *Jour. Ind. and Eng. Chem.*, Vol. 3, 1911, pp. 660–662.

method also gives an exceedingly low ash content, practically the same as that of the Rather method. It is a combination of the Rather and Hilgard methods, the extraction of humus being carried on in the same way as in the Hilgard method, with the exception that the ammonum carbonate has already been added to the 4 per cent. ammonium hydroxid. This causes the very fine clay particles to flocculate on the filter, and consequently prevents their being carried through. The method has thus far been tried but very briefly, only three such determinations having been made. The results of these, however, indicate that the method should be as reliable as the Hilgard, with the added advantage of the low ash-content, caused by the absence of any clay particles. It is, however, just as tedious as the Hilgard method, and therefore does not seem as practical as the Rather method for most gravimetric work.

### THE COLORIMETRIC METHOD

For soils which are very low in humus, however, the gravimetric determination is not entirely reliable and satisfactory. This is shown by the results obtained from gravimetric determinations on very light clay subsoil which should contain very little or no humus. Their extracts with 4 per cent. ammonia may have so little color that the eye can scarcely detect it, but a gravimetric determination will show .15 per cent. to .20 per cent. humus, whiie the humus ash will be practically the same as in soils of high humus content. It would seem from this that the 4 per cent. ammonia must dissolve a certain amount of material other than humus, from a soil. In surface soils, and soils of comparatively high humus content, the error introduced in this way is of slight consequence, but it is readily seen that in subsoils, and soils of low humus content, the percentage of error is considerably increased. Assuming that humus is the dark-colored organic material of the soil which is soluble in dilute alkalies, it was decided that for soils low in humus, a colorimetric determination would be of considerably more value than a gravimetric on the same soil, to say nothing of the great economy of time in the use of the colorimetric method. Colorimetric determinations were run on all of the samples, in order to have as complete a comparison as possible of the two methods. However, in reporting the humus content of the transition soils the gravimetric results are used in the case of samples from the first and the second feet, while for those from the third, fourth, fifth and sixth feet, the colorimetric results are employed. The colorimetric method involves simply a comparison of the color of the solution under investigation with the color of a known standard solution, the solutions being made up in the same manner as the solutions for the gravimetric determination. Alway and Pinckney,[2] who have previously worked on this method, describe it as follows: "A standard solution of convenient strength is prepared, and an aliquot portion, say 50 c.c., is placed in a Hehner or a Nessler cylinder. This is held beside a similar, but empty, cylinder vertically over a white plate in a good light. To the empty cylinder the humus solution under examination is slowly added until the same tint is observed in both. The results are most accurate when the standard is diluted to such an extent that the diluted solution is of about the same color as the solution under examination."

From the relative depth of the two solutions and the known strength of the standard, the strength of the unknown solution is readily computed by means of a simple proportion. In this particular work, however, the manipulation was made easier by the use of the "colorimeter," a contrivance in which the two cylinders containing the solutions may be moved up and down until the depth of color is the same in both solutions, the light being reflected up through a wooden chamber from a white glazed paper. The principle is essentially the same, however, in both cases.

## COMPARISON OF THE SOIL COLORS

Comparisons of the color, of the soils, themselves, both in a wet and in a dry state, were also made. This was done by putting 25 gr. samples in shallow porcelain dishes, and attempting to arrange them in order of humus content. This could be done with a fair degree of success where only soils from the same local-

[2] Agri. Exp. Sta. Uni. of Nebr. 25th Annual Report, 1910.

ity, and of the same general composition, were used; but when soils from different localities were used, attempts to arrange them in such a manner were not very satisfactory. For instance, when soils from Lincoln and Weeping Water were compared in this way with soils from Wauneta and McCook, a Lincoln soil containing .5 per cent humus was in no way similar in appearance to a Wauneta soil with the same humus content. This was, no doubt, due to the widely varying amounts of lime and iron in the two types of soil. The same difficulty was experienced in comparing any of the above mentioned soils with soils from Holdrege or Hastings. The differences in color were especially marked in the subsoils. Consequently, such a comparison of soils from different localities would be of very little significance, unless one were already very familiar with each soil in all of its characteristics. Where the solutions and the colorimeter are used, however, a striking concordance between the colorimetric and the gravimetric results is generally noticed, excepting in the very weak solutions taken from soils of very low humus content. It is also observed that better results are obtained when the standard is a soil of the same type and locality as the soil under investigation.

### THE PHOTOMETRIC METHOD

Another method which was tried briefly, and which is especially applicable to soils containing 1.00 per cent or more of humus, is the photometric method, which is a modification of the colorimetric method. In this method it is particularly advisable to use a standard from the same locality as the sample being analyzed. Alway and Pinckney[3] did considerable work on this method and describe it as follows: "As a source of light a candle is used, it being placed in a box with a hole, half an inch in diameter, in the top. The candle is held in a clamp 24 inches below the top of the box. Two Hehner cylinders, both of the same internal diameter, are connected by means of a rubber tube, both stopcocks closed and the one cylinder partly filled with the standard solution. The empty cylinder is placed over the opening in the top of the

[3] Agri. Exp. Sta. Uni. of Nebr. 25th Annual Report.

box and the cylinder containing the standard supported on a stand at a height of 6 to 12 inches above the former. After lighting the candle and darkening the room as much as possible, the stopcock of the higher cylinder is opened wide. While the operator has one hand on the stopcock of the lower cylinder and has one eye over the latter, watching the candle flame, the solution is allowed to slowly enter until the flame just disappears. Then the stopcock is closed and the height of the column of solution recorded, after which the lower cylinder is raised and the stopcock opened so that part of the solution flows back into the other cylinder. Then the determination is repeated until two or three successive readings give approximately the same height, the average of these being used in the calculation. After thus determining the depth of the column of the standard extract required to hide the candle flame, similar determinations were made with all the extracts. It much simplifies the calculations if in all cases equal weights of soil have been extracted and the extracts have been made up to the same volume. . . . Where the same graduated cylinders, both of the same internal diameter, are used in all cases, it suffices to record the volume of the extract required to hide the candle flame. Otherwise, it is necessary to measure the depth of the column of solution. . . . Provided that the same weight of soil has been used and that the humus extracts have been made up to the same volume, the percentages of humus will vary inversely as the heights of the columns of extract required to hide the candle flame." This method was tried only in the case of some of the soils of high humus content, and with indifferent success.

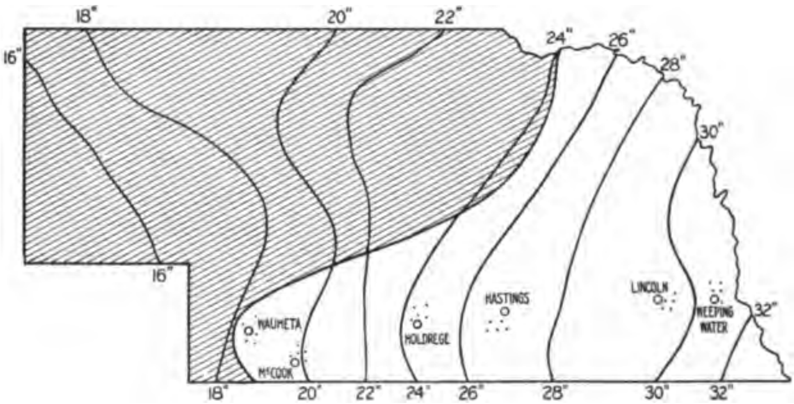
The above, in brief, are the methods tried, and as indicated before, the Rather method was adopted for the preparation of the humus extracts.

### DETERMINATION OF TOTAL NITROGEN

But very few total nitrogen determinations were made, since the totals on both the individual fields and the composites of the transition series had previously been made by Mr. McDole, of this station, and his figures were made use of in calculating the humus-nitrogen ratios. Any nitrogen determinations that were made, however, were made by the Kjeldahl method, which is too well known to need any description.

THE DETERMINATION OF HUMUS NITROGEN

A considerable number of determinations of nitrogen in humus, or "humus nitrogen" were made, however, and but two methods were tried. These two are the Hilgard method and the Alway-Bishop method. The extraction in the Hilgard method is carried out in the same manner as the extraction in the determination of humus by the Hilgard method, except that 4 per cent potassium hydroxid instead of ammonium hydroxide is used; a determina-




MAP OF NEBRASKA, SHOWING OUTLINE OF THE LOESS AREA (UNSHADED), THE LOCATION OF THE PRAIRIE FIELDS SAMPLED, AND THE NORMAL ANNUAL PRECIPITATION

tion of nitrogen in this extract is then carried out by the Kjeldahl method. In the Alway-Bishop[4] method, however, the extraction is made in a different manner. The extraction is started in the same way as in the Official method for the determination of humus, with the exception that 4 per cent potassium hydroxide in place of 4 per cent ammonium hydroxide is used, and the containers are allowed to remain eight days, with an occasional shaking

[4] E. S. Bishop. Thesis for Master's degree, Univ. of Nebr., 1911.

before the supernatant liquid is drawn off. Then, as in the Hilgard method, the Kjeldahl nitrogen determination is run on the extract. In order to obtain a check on the results in both these methods, a nitrogen determination is also run on the soil residues left after the extraction is completed. The two results are then added together, and the total should equal the total nitrogen content as determined in a separate analysis. The Alway-Bishop method gives results slightly higher than those of the Hilgard method. This is, no doubt, due to a more complete extraction by the Alway-Bishop method. The Alway-Bishop method was adopted for this work, because, although it takes eight days for the extraction, it does not require any attention, other than an occasional shaking, after once started. The Hilgard method, however, requires constant attention, and may take several days, also, before the extraction is complete; so that, on the whole, more actual time is consumed in the Hilgard method than in the Alway-Bishop method.

TABLE I. COMPARISON OF DIFFERENT METHODS FOR THE DETERMINATION OF HUMUS

| | Official Method | | Hilgard Method | | Rather Method | | Blish Method | |
|---|---|---|---|---|---|---|---|---|
| | Humus, Per Cent | Humus Ash, Per Cent | Humus, Per Cent | Humus Ash, Per Cent | Humus, Per Cent | Humus Ash, Per Cent | Humus, Per Cent | Humus Ash, Per Cent |
| 1 | 3.58 | 6.78 | 2.32 | .64 | 2.02 | .19 | 2.19 | .26 |
| 2 | 3.44 | 5.40 | 2.14 | .74 | 2.16 | .38 | 2.40 | .24 |
| 3 | ...... | ...... | 2.42 | .68 | 2.12 | .60 | 2.40 | .24 |
| 4 | ...... | ...... | 2.23 | 1.30 | 2.24 | .63 | ...... | ...... |
| 5 | ...... | ...... | 2.13 | .87 | 2.20 | .55 | ...... | ...... |
| 6 | ...... | ...... | 2.24 | 1.41 | 2.19 | .63 | ...... | ...... |
| 7 | ...... | ...... | 2.17 | 1.33 | 2.15 | .68 | ...... | ...... |
| Average............ | 3.51 | 6.09 | 2.23 | 1.14 | 2.15 | .52 | 2.33 | .25 |

In Table I are shown the results of gravimetric humus determinations on Lincoln surface soil, using the different methods described in the preceding pages.

Table II shows the results of humus-nitrogen determination by the Hilgard and the Alway-Bishop methods, using Lincoln surface soil in all instances.

TABLE II. HUMUS NITROGEN IN LINCOLN SURFACE SOIL

| Determination Number | Humus Nitrogen Hilgard Method, Per Cent | Humus Nitrogen Alway-Bishop Method, Per Cent |
|---|---|---|
| 1 | .139 | .161 |
| 2 | .140 | .160 |
| 3 | .131 | .154 |
| 4 | .130 | .157 |
| 5 | .128 | .156 |
| 6 | .144 | .157 |
| 7 | .142 | .162 |
| 8 | .137 | .162 |
| 9 | .137 | .160 |
| 10 | .142 | .160 |
| 11 | .... | .159 |
| Average | .137 | .160 |

Total nitrogen in L. S. soil averaged .244 per cent. Per cent. of nitrogen in humus = 7.3 per cent.

$$\frac{\text{Humus}}{\text{total nitrogen}} = 9.0.$$

The following set of tables shows the humus content of the soils from each of the five fields of each area of the Transition series. Also, the humus-nitrogen ratios are given for the first two feet of each field; lower than this the ratio has but little significance, since a slight error, or variation in a humus determination, causes an exceedingly large variation in the ratio, and the per cent of error in the humus determination of a subsoil is necessarily large, so that below the first two feet the ratios are not very constant. The per cent of nitrogen in humus is given for the first foot of all soils. This is the only depth in the case of samples from the individual fields on which humus nitrogen determinations were made. They were run on the composites from all depths, however, but owing to the unreliability of a humus determination below the first two feet, they are of little significance.

In the following set of tables, the humus content was determined gravimetrically for all samples from the first and second feet, while for samples from below the second foot, the colorimetric results are considered a more correct and reliable estimate of the humus.

TABLE III. SOILS FROM THE WAUNETA AREA

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft. | 0.99 | 1.04 | 1.07 | 0.99 | 1.02 | 1.02 |
| 2d ft. | .65 | .61 | .72 | .67 | .64 | .65 |
| 3d ft. | .74 | 1.08 | .74 | .93 | .50 | .80 |
| 4th ft. | .39 | 1.00 | .70 | .58 | .34 | .60 |
| 5th ft. | .26 | .31 | .87 | .26 | .20 | .38 |
| 6th ft. | .18 | .19 | .82 | .15 | .17 | .30 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 7.33 | 7.53 | 7.43 | 7.67 | 7.72 | 7.53 |
| 2d ft. | 8.12 | 7.82 | 7.82 | 8.17 | 8.10 | 7.92 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 8.3 | 8.0 | 8.0 | 7.8 | 7.7 | 8.0 |

TABLE IV. SOILS FROM THE McCOOK AREA

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft. | 1.12 | 1.27 | 1.15 | 1.15 | 1.04 | 1.15 |
| 2d ft. | .55 | .81 | .60 | .67 | .49 | .62 |
| 3d ft. | .39 | 1.04 | .33 | .45 | .19 | .48 |
| 4th ft. | .33 | .82 | .22 | .24 | .18 | .36 |
| 5th ft. | .19 | .30 | .31 | .19 | .17 | .23 |
| 6th ft. | .21 | .19 | .24 | .16 | .14 | .19 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 7.83 | 8.70 | 8.33 | 8.04 | 8.32 | 8.28 |
| 2d ft. | 7.00 | 9.00 | 7.50 | 7.61 | 5.76 | 7.38 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 8.0 | 7.2 | 7.4 | 7.5 | 7.5 | 7.5 |

### Table V. Soils from the Holdrege Area

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft. | 1.37 | 1.44 | 1.63 | 1.70 | 1.90 | 1.61 |
| 2d ft. | .69 | .79 | 1.01 | .95 | .93 | .87 |
| 3d ft. | .37 | .44 | .66 | .70 | .39 | .51 |
| 4th ft. | .22 | .25 | .44 | .58 | .24 | .34 |
| 5th ft. | .16 | .19 | .22 | .16 | .15 | .18 |
| 6th ft. | .13 | .15 | .20 | .10 | .13 | .14 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 8.00 | 8.27 | 9.94 | 9.00 | 9.09 | 8.90 |
| 2d ft. | 7.75 | 8.06 | 9.10 | 9.13 | 9.03 | 8.61 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 7.6 | 7.5 | 6.8 | 7.00 | 6.5 | 7.1 |

### Table VI. Soils from the Hastings Area

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft. | 1.50 | 1.67 | 1.39 | 1.56 | 1.42 | 1.51 |
| 2d ft. | .85 | .92 | .84 | .91 | .79 | .86 |
| 3d ft. | .42 | .50 | .40 | .36 | .28 | .39 |
| 4th ft. | .26 | .41 | .17 | .30 | .15 | .23 |
| 5th ft. | .23 | .41 | .14 | .29 | .13 | .22 |
| 6th ft. | .13 | .30 | .10 | .15 | .12 | .14 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 8.77 | .......... | 7.59 | 9.23 | 8.16 | 8.40 |
| 2d ft. | 8.94 | .......... | 8.23 | 9.78 | 7.50 | 8.67 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft. | 8.40 | 7.5 | 8.0 | 8.4 | 7.6 | 8.0 |

TABLE VII. SOILS FROM THE LINCOLN AREA

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft........... | 2.30 | 2.22 | 2.19 | 2.27 | 2.34 | 2.26 |
| 2d ft........... | 1.08 | .96 | .80 | .90 | 1.16 | .98 |
| 3d ft........... | .17 | .13 | .11 | .23 | .26 | .18 |
| 4th ft........... | .09 | .08 | .06 | .12 | .12 | .09 |
| 5th ft........... | .04 | .05 | .05 | .09 | .10 | .07 |
| 6th ft........... | .05 | .07 | .05 | .06 | .09 | .06 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft........... | 9.54 | 9.06 | 9.35 | 9.53 | 9.67 | 9.42 |
| 2d ft........... | 8.85 | 6.62 | 6.45 | 7.37 | 8.72 | 7.60 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft........... | 6.6 | 6.5 | 6.6 | 6.5 | 6.7 | 6.6 |

TABLE VIII. SOILS FROM THE WEEPING WATER AREA

*Humus*

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| 1st ft........... | 2.13 | 2.09 | 2.24 | 2.43 | 2.28 | 2.24 |
| 2d ft........... | 1.18 | 1.30 | 1.08 | 1.65 | 1.27 | 1.29 |
| 3d ft........... | .14 | .10 | .15 | .14 | .11 | .13 |
| 4th ft........... | .07 | .08 | .11 | .10 | .09 | .09 |
| 5th ft........... | .06 | .06 | .04 | .08 | .08 | .06 |
| 6th ft........... | .06 | .05 | .04 | .04 | .04 | .05 |

*Humus-Nitrogen Ratio*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft........... | 9.34 | 9.00 | 9.25 | 10.00 | 9.20 | 9.49 |
| 2d ft........... | 7.94 | 8.72 | 7.40 | 9.65 | 8.30 | 8.43 |

*Per Cent of Nitrogen in the Humus*

| | | | | | | |
|---|---|---|---|---|---|---|
| 1st ft........... | 6.9 | 7.2 | 7.4 | 6.5 | 6.5 | 6.9 |

TABLE IX. HUMUS ASH CONTENT OF THE INDIVIDUAL FIELDS[5]

| Depth | Field 1, Per Cent | Field 2, Per Cent | Field 3, Per Cent | Field 4, Per Cent | Field 5, Per Cent | Average, Per Cent |
|---|---|---|---|---|---|---|
| *Wauneta Area* | | | | | | |
| 1st ft.......... | .40 | .33 | .45 | .34 | .42 | .39 |
| 2d ft........... | .34 | .27 | .35 | .32 | .32 | .32 |
| *McCook Area* | | | | | | |
| 1st ft.......... | .29 | .32 | .30 | .29 | .26 | .29 |
| 2d ft........... | .35 | .27 | .36 | .31 | .36 | .33 |
| *Holdrege Area* | | | | | | |
| 1st ft.......... | .30 | .29 | .29 | .34 | .29 | .30 |
| 2d ft........... | .25 | .23 | .30 | .28 | .28 | .27 |
| *Hastings Area* | | | | | | |
| 1st ft.......... | .24 | .19 | .20 | .27 | .23 | .23 |
| 2d ft........... | .27 | .22 | .27 | .21 | .22 | .24 |
| *Lincoln Area* | | | | | | |
| 1st ft.......... | .26 | .38 | .25 | .22 | .31 | .28 |
| 2d ft........... | .43 | .18 | .15 | .19 | .16 | .22 |
| *Weeping Water Area* | | | | | | |
| 1st ft.......... | .29 | .28 | .36 | .32 | .37 | .32 |
| 2d ft........... | .16 | .16 | .14 | .34 | .18 | .20 |

The following Tables Nos. X, XI and XII show work done on the composites from the individual fields of the Transition series. Each composite represents five individual fields. Since samples were taken at depths of 1, 2, 3, 4, 5 and 6 feet, there are six composites for each area. The humus, humus ash and humus nitrogen determinations were run in duplicate and are shown in duplicate in the tables. In calculating the per cent of nitrogen in humus and the humus-nitrogen ratio, an average of the duplicates was taken in all cases.

[5] Gravimetric determinations were made on only the first two feet.

TABLE X. HUMUS AND HUMUS ASH IN COMPOSITE SAMPLES FROM DIFFERENT AREAS

*Humus*

| Depth | Wauneta | | McCook | | Holdrege | | Hastings | | Lincoln | | Weeping Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1st ft. | 1.08 | 1.00 | 1.07 | 1.04 | 1.68 | 1.70 | 1.65 | 1.60 | 2.30 | 2.40 | 2.37 | 2.27 |
| 2d ft. | .36 | .38 | .47 | .48 | .72 | .71 | .62 | .63 | 1.04 | 1.02 | 1.12 | 1.11 |
| 3d ft. | .51 | .46 | .36 | .35 | .34 | .32 | .36 | .35 | .39 | .38 | .54 | .57 |
| 4th ft. | .35 | .34 | .32 | .31 | .29 | .29 | .26 | .26 | .24 | .27 | .26 | .28 |
| 5th ft. | .26 | .27 | .26 | .28 | .22 | .20 | .30 | .26 | .20 | .22 | .23 | .24 |
| 6th ft. | .30 | .23 | .27 | .27 | .18 | .18 | .25 | .25 | .12 | .18 | .16 | .22 |

*Humus Ash*

| Depth | Wauneta 1 | Wauneta 2 | McCook 1 | McCook 2 | Holdrege 1 | Holdrege 2 | Hastings 1 | Hastings 2 | Lincoln 1 | Lincoln 2 | Weeping Water 1 | Weeping Water 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft. | .60 | .48 | .57 | .58 | .64 | .65 | .82 | .78 | 1.32 | 1.28 | 1.17 | 1.17 |
| 2d ft. | .42 | .43 | .36 | .35 | .30 | .30 | .24 | .20 | .20 | .12 | .26 | .21 |
| 3d ft. | .35 | .40 | .44 | .49 | .31 | .37 | .26 | .28 | .18 | .21 | .26 | .20 |
| 4th ft. | .47 | .44 | .51 | .54 | .34 | .40 | .39 | .40 | .22 | .29 | .17 | .22 |
| 5th ft. | .56 | .50 | .54 | .55 | .36 | .38 | .41 | .40 | .25 | .24 | .28 | .27 |
| 6th ft. | .62 | .58 | .56 | .53 | .38 | .40 | .42 | .46 | .36 | .32 | .32 | .22 |

TABLE XI. HUMUS NITROGEN IN THE COMPOSITES

| Depth | Wauneta | | McCook | | Holdrege | | Hastings | | Lincoln | | Weeping Water | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| 1st ft. | .080 | .082 | .082 | .085 | .110 | .115 | .110 | .113 | .143 | .140 | .145 | .143 |
| 2d ft. | .022 | .022 | .032 | .035 | .046 | .045 | .045 | .045 | .067 | .067 | .087 | .087 |
| 3d ft. | .036 | .035 | .015 | .015 | .021 | .022 | .018 | .016 | .029 | ..... | .040 | .035 |
| 4th ft. | .034 | .032 | .004 | .004 | .010 | .009 | .008 | .007 | .015 | .014 | .021 | .023 |
| 5th ft. | .015 | .015 | .002 | .003 | .004 | .003 | .003 | .003 | .010 | .010 | .012 | .012 |
| 6th ft. | .013 | .014 | .001 | .001 | .002 | .002 | .003 | .003 | .010 | .010 | .007 | .006 |

*Per Cent of Nitrogen in Humus*

| Depth | Wauneta | McCook | Holdrege | Hastings | Lincoln | Weeping Water |
|---|---|---|---|---|---|---|
| 1st ft. | 7.80 | 7.90 | 6.62 | 6.20 | 6.04 | 6.20 |
| 2d ft. | 6.52 | 7.00 | 6.34 | 7.26 | 6.5 | 8.05 |
| 3d ft. | 7.10 | 4.29 | 6.36 | 4.60 | 7.63 | 6.50 |
| 4th ft. | 9.12 | 1.30 | 3.45 | 3.10 | 6.00 | 8.15 |
| 5th ft. | 6.15 | 1.11 | 2.00 | 1.10 | 4.7 | 5.21 |
| 6th ft. | 5.18 | .40 | 1.11 | 1.20 | 6.60 | 3.68 |

Tables No. XI and XII show the humus nitrogen, the per cent of nitrogen in humus and humus-nitrogen ratio of all of the composites of the transition series, using the figures for only gravimetric humus determinations.

TABLE XII. HUMUS-NITROGEN RATIO FOR COMPOSITE SAMPLES FROM DIFFERENT AREAS

| Depth, Feet | Wauneta | McCook | Holdrege | Hastings | Lincoln | Weeping Water |
|---|---|---|---|---|---|---|
| 1 | 7.7 | 7.5 | 9.3 | 9.3 | 9.75 | 10.00 |
| 2 | 7.11 | 5.60 | 7.03 | 6.32 | 8.00 | 7.06 |
| 3 | 7.5 | 6.48 | 5.10 | 6.50 | 5.5 | 6.86 |
| 4 | 7.4 | 8.16 | 6.44 | 6.34 | 4.16 | 4.41 |
| 5 | 6.8 | 8.40 | 6.36 | 8.5 | 5.00 | 5.35 |
| 6 | 9.0 | 9.00 | 5.30 | 8.93 | 3.50 | 5.00 |

As previously indicated, considerable work was done on the estimation of humus in the soils of the transition series by different colorimetric methods. Solutions or extracts of humus in 4 per cent ammonia were prepared by the usual method from each individual field soil, making 180 solutions in all. These solutions, of course, varied in depth of color from deep black to almost colorless solutions. They were compared, first with the eye alone, and later the humus content in each was estimated, using a standard and a colorimeter. Colorimetric comparisons were also made using merely the soil itself, both in a moist and a dry condition. Twenty-five gram samples were weighed out in small porcelain dishes, and attempts were made to arrange them according to amount of humus, this being estimated by the depth of color in the soil. The results of the latter were fairly satisfactory when the soils were from the same locality, but when soils of different localities were brought together, the extreme differences in types of color, caused by substances other than humus, such as lime and iron, made a satisfactory and reliable comparison by this method impossible. This is shown by the following tables. From them it is seen that when soils of the same area were taken, they were arranged fairly accurately according to depth of color, but when all were mixed together, the uniformity of the gradation is lost, and with the exception of those soils which differ very widely in humus content, they seem to have been arranged in an almost haphazard manner. The idea, as expressed by the following table, was to arrange the soils, one after another, according to humus content, by judging from the depth of color, starting with the soils of high humus content, and gradually passing to those of low humus content. The arrangements of the areas, individually, are shown first, and

TABLE XIII. ARRANGEMENT OF SOILS OF EACH AREA, INDIVIDUALLY, WITH REGARD TO DEPTH OF COLOR

*A. Wauneta Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 2875 | 1 | 1 | 1.17 | 1 | 1 |
| 2914 | 3 | 1 | 1.17 | 2 | 2 |
| 2935 | 4 | 1 | 1.00 | 3 | 4 |
| 2894 | 2 | 1 | 1.00 | 4 | 5 |
| 2956 | 5 | 1 | 1.00 | 5 | 6 |
| 2936 | 4 | 2 | .93 | 6 | 8 |
| 2937 | 4 | 3 | .93 | 7 | 9 |
| 2915 | 3 | 2 | .87 | 8 | 10 |
| 2896 | 2 | 3 | 1.08 | 9 | 3 |
| 2876 | 1 | 2 | .87 | 10 | 11 |
| 2957 | 5 | 2 | .74 | 11 | 15 |
| 2895 | 2 | 2 | .78 | 12 | 14 |
| 2897 | 2 | 4 | 1.00 | 13 | 7 |
| 2938 | 4 | 4 | .58 | 14 | 19 |
| 2916 | 3 | 3 | .74 | 15 | 16 |
| 2877 | 1 | 3 | .74 | 16 | 17 |
| 2917 | 3 | 4 | .70 | 17 | 18 |
| 2919 | 3 | 6 | .82 | 18 | 13 |
| 2958 | 5 | 3 | .50 | 19 | 20 |
| 2918 | 3 | 5 | .87 | 20 | 12 |
| 2878 | 1 | 4 | .39 | 21 | 21 |
| 2898 | 2 | 5 | .31 | 22 | 23 |
| 2939 | 4 | 5 | .26 | 23 | 24 |
| 2959 | 5 | 4 | .34 | 24 | 22 |
| 2879 | 1 | 5 | .26 | 25 | 25 |
| 2960 | 5 | 5 | .20 | 26 | 26 |
| 2899 | 2 | 6 | .19 | 27 | 27 |
| 2940 | 4 | 6 | .15 | 28 | 30 |
| 2961 | 5 | 6 | .17 | 29 | 29 |
| 2880 | 1 | 6 | .15 | 30 | 28 |

finally the arrangement of the soils from all six areas, taken collectively. The amounts of humus determined by the colorimetric method are used in this case.

*B. McCook Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 2995 | 2 | 1 | 1.48 | 1 | 1 |
| 3014 | 3 | 1 | 1.17 | 2 | 2 |
| 3020 | 4 | 1 | 1.08 | 3 | 3 |
| 2976 | 1 | 1 | .93 | 4 | 7 |
| 3039 | 5 | 1 | 1.00 | 5 | 6 |
| 2996 | 2 | 2 | 1.08 | 6 | 4 |
| 3021 | 4 | 2 | .82 | 7 | 9 |
| 2997 | 2 | 3 | 1.04 | 8 | 5 |
| 3015 | 3 | 2 | .61 | 9 | 10 |
| 3040 | 5 | 2 | .40 | 10 | 13 |
| 2977 | 1 | 2 | .52 | 11 | 11 |
| 2999 | 2 | 5 | .30 | 12 | 18 |
| 2998 | 2 | 4 | .82 | 13 | 8 |
| 3022 | 4 | 3 | .45 | 14 | 12 |
| 2978 | 1 | 3 | .39 | 15 | 14 |
| 3016 | 3 | 3 | .33 | 16 | 15 |
| 3041 | 5 | 3 | .19 | 17 | 23 |
| 2979 | 1 | 4 | .33 | 18 | 16 |
| 3042 | 5 | 4 | .18 | 19 | 27 |
| 3017 | 3 | 4 | .22 | 20 | 21 |
| 3018 | 3 | 5 | .31 | 21 | 17 |
| 3024 | 4 | 5 | .19 | 22 | 24 |
| 3023 | 4 | 4 | .24 | 23 | 19 |
| 3019 | 3 | 6 | .24 | 24 | 20 |
| 3042 | 5 | 5 | .17 | 25 | 28 |
| 2980 | 1 | 5 | .19 | 26 | 25 |
| 3044 | 5 | 6 | .14 | 27 | 30 |
| 3000 | 2 | 6 | .19 | 28 | 26 |
| 3025 | 4 | 6 | .16 | 29 | 29 |
| 2981 | 1 | 6 | .21 | 30 | 22 |

## *C. Holdrege Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 3115 | 4 | 1 | 2.00 | 1 | 2 |
| 3096 | 3 | 1 | 1.75 | 2 | 3 |
| 3135 | 5 | 1 | 2.15 | 3 | 1 |
| 3077 | 2 | 1 | 1.65 | 4 | 4 |
| 3058 | 1 | 1 | 1.48 | 5 | 5 |
| 3097 | 3 | 2 | 1.33 | 6 | 6 |
| 3116 | 4 | 2 | 1.17 | 7 | 7 |
| 3078 | 2 | 2 | 1.04 | 8 | 9 |
| 3136 | 5 | 2 | 1.17 | 9 | 8 |
| 3059 | 1 | 2 | .78 | 10 | 10 |
| 3098 | 3 | 3 | .66 | 11 | 12 |
| 3117 | 4 | 3 | .70 | 12 | 11 |
| 3079 | 2 | 3 | .44 | 13 | 14 |
| 3137 | 5 | 3 | .39 | 14 | 16 |
| 3060 | 1 | 3 | .37 | 15 | 17 |
| 3099 | 3 | 4 | .44 | 16 | 15 |
| 3118 | 4 | 4 | .58 | 17 | 13 |
| 3138 | 5 | 4 | .24 | 18 | 20 |
| 3139 | 5 | 5 | .15 | 19 | 26 |
| 3061 | 1 | 4 | .22 | 20 | 21 |
| 3100 | 3 | 5 | .22 | 21 | 22 |
| 3081 | 2 | 5 | .25 | 22 | 18 |
| 3062 | 1 | 5 | .16 | 23 | 24 |
| 3080 | 2 | 4 | .25 | 24 | 19 |
| 3140 | 5 | 6 | .13 | 25 | 28 |
| 3119 | 4 | 5 | .16 | 26 | 25 |
| 3082 | 2 | 6 | .15 | 27 | 27 |
| 3063 | 1 | 6 | .13 | 28 | 29 |
| 3101 | 3 | 6 | .20 | 29 | 23 |
| 3120 | 1 | 6 | .10 | 30 | 30 |

*D. Hastings Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 3210 | 4 | 1 | 1.55 | 1 | 2 |
| 3229 | 5 | 1 | 1.55 | 2 | 3 |
| 3153 | 1 | 1 | 1.40 | 3 | 4 |
| 3191 | 3 | 1 | 1.26 | 4 | 5 |
| 3172 | 2 | 1 | 1.67 | 5 | 1 |
| 3173 | 2 | 2 | .92 | 6 | 7 |
| 3211 | 4 | 2 | 1.00 | 7 | 6 |
| 3192 | 3 | 2 | .82 | 8 | 8 |
| 3154 | 1 | 2 | .82 | 9 | 9 |
| 3230 | 5 | 2 | .82 | 10 | 10 |
| 3174 | 2 | 3 | .50 | 11 | 11 |
| 3193 | 3 | 3 | .40 | 12 | 15 |
| 3155 | 1 | 3 | .42 | 13 | 12 |
| 3212 | 4 | 3 | .36 | 14 | 16 |
| 3175 | 2 | 4 | .41 | 15 | 14 |
| 3231 | 5 | 3 | .28 | 16 | 20 |
| 3176 | 2 | 5 | .41 | 17 | 13 |
| 3156 | 1 | 4 | .26 | 18 | 21 |
| 3177 | 2 | 6 | .30 | 19 | 17 |
| 3213 | 4 | 4 | .30 | 20 | 18 |
| 3214 | 4 | 5 | .29 | 21 | 19 |
| 3194 | 3 | 4 | .17 | 22 | 23 |
| 3232 | 5 | 4 | .15 | 23 | 25 |
| 3233 | 5 | 5 | .13 | 24 | 27 |
| 3234 | 5 | 6 | .12 | 25 | 29 |
| 3215 | 4 | 6 | .15 | 26 | 24 |
| 3195 | 3 | 5 | .14 | 27 | 26 |
| 3157 | 1 | 5 | .23 | 28 | 22 |
| 3196 | 3 | 6 | .10 | 29 | 30 |
| 3158 | 1 | 6 | .13 | 30 | 28 |

*E. Lincoln Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 3267 | 1 | 1 | 2.55 | 1 | 1 |
| 3339 | 5 | 1 | 2.33 | 2 | 3 |
| 3321 | 4 | 1 | 2.33 | 3 | 4 |
| 3285 | 2 | 1 | 2.55 | 4 | 2 |
| 3303 | 3 | 1 | 2.15 | 5 | 5 |
| 3340 | 5 | 2 | .84 | 6 | 7 |
| 3322 | 4 | 2 | .56 | 7 | 9 |
| 3268 | 1 | 2 | .87 | 8 | 6 |
| 3286 | 2 | 2 | .64 | 9 | 8 |
| 3304 | 3 | 2 | .30 | 10 | 10 |
| 3341 | 5 | 3 | .26 | 11 | 11 |
| 3323 | 4 | 3 | .23 | 12 | 12 |
| 3269 | 1 | 3 | .17 | 13 | 13 |
| 3287 | 2 | 3 | .13 | 14 | 14 |
| 3342 | 5 | 4 | .12 | 15 | 15 |
| 3343 | 5 | 5 | .10 | 16 | 18 |
| 3270 | 1 | 4 | .09 | 17 | 19 |
| 3288 | 2 | 4 | .08 | 18 | 22 |
| 3305 | 3 | 3 | .11 | 19 | 17 |
| 3324 | 4 | 4 | .12 | 20 | 16 |
| 3325 | 4 | 5 | .09 | 21 | 20 |
| 3344 | 5 | 6 | .09 | 22 | 21 |
| 3289 | 2 | 5 | .05 | 23 | 26 |
| 3271 | 1 | 5 | .04 | 24 | 30 |
| 3326 | 4 | 6 | .06 | 25 | 25 |
| 3290 | 2 | 6 | .07 | 26 | 23 |
| 3272 | 1 | 6 | .05 | 27 | 27 |
| 3306 | 3 | 4 | .06 | 28 | 24 |
| 3307 | 3 | 5 | .05 | 29 | 28 |
| 3308 | 3 | 6 | .05 | 30 | 29 |

*F. Weeping Water Area*

| Soil Number | Field | Depth, Feet | Humus, Per Cent | Rank of Soil | |
|---|---|---|---|---|---|
| | | | | by Color | by Humus Content |
| 3417 | 4 | 1 | 2.55 | 1 | 1 |
| 3436 | 5 | 1 | 2.15 | 2 | 3 |
| 3397 | 3 | 1 | 2.33 | 3 | 2 |
| 3377 | 2 | 1 | 2.00 | 4 | 5 |
| 3357 | 1 | 1 | 2.15 | 5 | 4 |
| 3418 | 4 | 2 | 1.40 | 6 | 6 |
| 3358 | 1 | 2 | .70 | 7 | 10 |
| 3378 | 2 | 2 | .72 | 8 | 8 |
| 3398 | 3 | 2 | .72 | 9 | 9 |
| 3437 | 5 | 2 | .78 | 10 | 7 |
| 3419 | 4 | 3 | .14 | 11 | 12 |
| 3359 | 1 | 3 | .14 | 12 | 13 |
| 3379 | 2 | 3 | .10 | 13 | 16 |
| 3438 | 5 | 3 | .11 | 14 | 14 |
| 3399 | 3 | 3 | .15 | 15 | 11 |
| 3420 | 4 | 4 | .10 | 16 | 17 |
| 3380 | 2 | 4 | .08 | 17 | 19 |
| 3439 | 5 | 4 | .09 | 18 | 18 |
| 3421 | 4 | 5 | .08 | 19 | 20 |
| 3400 | 3 | 4 | .11 | 20 | 15 |
| 3381 | 2 | 5 | .06 | 21 | 23 |
| 3360 | 1 | 4 | .07 | 22 | 22 |
| 3440 | 5 | 5 | .08 | 23 | 21 |
| 3361 | 1 | 5 | .06 | 24 | 24 |
| 3401 | 3 | 5 | .04 | 25 | 27 |
| 3402 | 3 | 6 | .04 | 26 | 28 |
| 3382 | 2 | 6 | .05 | 27 | 26 |
| 3421½ | 4 | 6 | .04 | 28 | 29 |
| 3362 | 1 | 6 | .06 | 29 | 25 |
| 3441 | 5 | 6 | .04 | 30 | 30 |

TABLE XIV. ARRANGEMENT OF SOILS OF ALL SIX AREAS IN ORDER OF COLOR OF THE MOIST SOILS

| Soil Number | Area | Field | Depth | Humus, Per Cent | Rank |
|---|---|---|---|---|---|
| 3417 | Weeping Water....... | 4 | 1 | 2.55 | 1 |
| 3436 | Weeping Water....... | 5 | 1 | 2.15 | 7 |
| 3377 | Weeping Water....... | 2 | 1 | 2.00 | 11 |
| 3285 | Lincoln.............. | 2 | 1 | 2.55 | 2 |
| 3267 | Lincoln.............. | 1 | 1 | 2.55 | 3 |
| 3339 | Lincoln.............. | 5 | 1 | 2.33 | 4 |
| 3321 | Lincoln.............. | 4 | 1 | 2.33 | 5 |
| 3303 | Lincoln.............. | 3 | 1 | 2.15 | 8 |
| 3357 | Weeping Water....... | 1 | 1 | 2.15 | 9 |
| 3397 | Weeping Water....... | 3 | 1 | 2.33 | 6 |
| 3135 | Holdrege............ | 5 | 1 | 2.15 | 10 |
| 3096 | Holdrege............ | 3 | 1 | 1.75 | 13 |
| 3077 | Holdrege............ | 2 | 1 | 1.65 | 17 |
| 3115 | Holdrege............ | 4 | 1 | 2.00 | 12 |
| 3058 | Holdrege............ | 1 | 1 | 1.48 | 18 |
| 3172 | Hastings............. | 2 | 1 | 1.67 | 14 |
| 3210 | Hastings............. | 4 | 1 | 1.55 | 15 |
| 3229 | Hastings............. | 5 | 1 | 1.55 | 16 |
| 2995 | McCook............. | 2 | 1 | 1.48 | 19 |
| 3191 | Hastings............. | 3 | 1 | 1.26 | 23 |
| 3153 | Hastings............. | 1 | 1 | 1.40 | 20 |
| 2914 | Wauneta............ | 3 | 1 | 1.17 | 24 |
| 2875 | Wauneta............ | 1 | 1 | 1.17 | 25 |
| 2935 | Wauneta............ | 4 | 1 | 1.00 | 37 |
| 3020 | McCook............. | 4 | 1 | 1.08 | 29 |
| 2956 | Wauneta............ | 5 | 1 | 1.00 | 38 |
| 3014 | Wauneta............ | 3 | 1 | 1.17 | 26 |
| 2894 | Wauneta............ | 2 | 1 | 1.00 | 34 |
| 2915 | Wauneta............ | 3 | 2 | .87 | 43 |
| 2897 | Wauneta............ | 2 | 4 | 1.00 | 35 |
| 3418 | Weeping Water....... | 4 | 2 | 1.40 | 21 |
| 2896 | Wauneta............ | 2 | 3 | 1.08 | 30 |
| 3078 | Holdrege............ | 2 | 2 | 1.04 | 32 |
| 2936 | Wauneta............ | 4 | 2 | .93 | 40 |
| 3039 | McCook............. | 5 | 1 | 1.00 | 36 |
| 3097 | Holdrege............ | 3 | 2 | 1.33 | 22 |
| 3173 | Hastings............. | 2 | 2 | .92 | 43 |
| 2996 | McCook............. | 2 | 2 | 1.08 | 31 |
| 2937 | Wauneta............ | 4 | 3 | .93 | 41 |
| 2976 | McCook............. | 1 | 1 | .93 | 42 |
| 3136 | Holdrege............ | 5 | 2 | 1.17 | 27 |
| 2895 | Wauneta............ | 2 | 2 | .78 | 54 |
| 3059 | Holdrege............ | 1 | 2 | .78 | 55 |
| 3021 | McCook............. | 4 | 2 | .82 | 48 |
| 2916 | Wauneta............ | 3 | 3 | .74 | 57 |
| 2876 | Wauneta............ | 1 | 2 | .87 | 44 |
| 2917 | Wauneta............ | 3 | 4 | .70 | 62 |
| 2918 | Wauneta............ | 3 | 5 | .87 | 45 |
| 2919 | Wauneta............ | 3 | 6 | .87 | 49 |

| Soil Number | Area | Field | Depth | Humus, Per Cent | Rank |
|---|---|---|---|---|---|
| 2957 | Wauneta | 5 | 2 | .74 | 58 |
| 3116 | Holdrege | 4 | 2 | 1.17 | 28 |
| 3268 | Lincoln | 1 | 2 | .87 | 46 |
| 3154 | Hastings | 1 | 2 | .87 | 50 |
| 3098 | Holdrege | 3 | 3 | .66 | 65 |
| 2877 | Wauneta | 1 | 3 | .74 | 59 |
| 2938 | Wauneta | 4 | 4 | .58 | 68 |
| 3230 | Hastings | 5 | 2 | .82 | 51 |
| 3340 | Lincoln | 5 | 2 | .84 | 47 |
| 3211 | Hastings | 4 | 2 | 1.00 | 39 |
| 3437 | Weeping Water | 5 | 2 | .78 | 56 |
| 3378 | Weeping Water | 2 | 2 | .72 | 60 |
| 3398 | Weeping Water | 3 | 2 | .72 | 61 |
| 2997 | McCook | 2 | 3 | 1.04 | 33 |
| 2977 | McCook | 1 | 2 | .52 | 71 |
| 3358 | Weeping Water | 1 | 2 | .70 | 63 |
| 3304 | Lincoln | 3 | 2 | .30 | 91 |
| 3322 | Lincoln | 4 | 2 | .56 | 70 |
| 3192 | Hastings | 3 | 2 | .82 | 52 |
| 3015 | McCook | 3 | 2 | .61 | 67 |
| 3175 | Hastings | 2 | 4 | .41 | 77 |
| 3117 | Holdrege | 4 | 3 | .70 | 64 |
| 3079 | Holdrege | 2 | 3 | .44 | 75 |
| 2998 | McCook | 2 | 4 | .82 | 53 |
| 3176 | Hastings | 2 | 5 | .41 | 78 |
| 3231 | Hastings | 5 | 3 | .28 | 96 |
| 3174 | Hastings | 2 | 3 | .50 | 72 |
| 3022 | McCook | 4 | 3 | .45 | 74 |
| 2978 | McCook | 1 | 3 | .39 | 81 |
| 3214 | Hastings | 4 | 5 | .29 | 95 |
| 2981 | McCook | 1 | 6 | .21 | 111 |
| 2959 | Wauneta | 5 | 4 | .34 | 86 |
| 3060 | Holdrege | 1 | 3 | .37 | 84 |
| 3212 | Hastings | 4 | 3 | .36 | 85 |
| 3286 | Lincoln | 2 | 2 | .64 | 66 |
| 2940 | Wauneta | 4 | 6 | .15 | 129 |
| 2898 | Wauneta | 2 | 5 | .31 | 89 |
| 3138 | Holdrege | 5 | 4 | .24 | 103 |
| 3118 | Holdrege | 4 | 4 | .58 | 69 |
| 2878 | Wauneta | 1 | 4 | .39 | 82 |
| 2999 | McCook | 2 | 5 | .30 | 92 |
| 2939 | Wauneta | 4 | 5 | .26 | 98 |
| 2879 | Wauneta | 1 | 5 | .26 | 99 |
| 3041 | McCook | 5 | 3 | .19 | 114 |
| 3061 | Holdrege | 1 | 4 | .22 | 106 |
| 3100 | Holdrege | 3 | 5 | .22 | 108 |
| 2958 | Wauneta | 5 | 3 | .50 | 73 |
| 3081 | Holdrege | 2 | 5 | .19 | 115 |
| 2899 | Wauneta | 2 | 6 | .19 | 116 |
| 3213 | Hastings | 4 | 4 | .30 | 93 |

| Soil Number | Area | Field | Depth | Humus, Per Cent | Rank |
|---|---|---|---|---|---|
| 3137 | Holdrege | 5 | 3 | .39 | 83 |
| 3023 | McCook | 4 | 4 | .24 | 104 |
| 3099 | Holdrege | 3 | 4 | .44 | 76 |
| 3016 | McCook | 3 | 3 | .33 | 87 |
| 3019 | McCook | 3 | 6 | .24 | 105 |
| 3040 | McCook | 5 | 2 | .40 | 79 |
| 3156 | Hastings | 1 | 4 | .26 | 100 |
| 3177 | Hastings | 2 | 6 | .30 | 94 |
| 3193 | Hastings | 3 | 3 | .40 | 80 |
| 2980 | McCook | 1 | 5 | .19 | 117 |
| 2979 | McCook | 1 | 4 | .33 | 88 |
| 3215 | Hastings | 4 | 6 | .15 | 130 |
| 3025 | McCook | 4 | 6 | .16 | 126 |
| 3017 | McCook | 3 | 4 | .22 | 109 |
| 3232 | Hastings | 5 | 4 | .15 | 131 |
| 3063 | Holdrege | 1 | 6 | .13 | 138 |
| 3024 | McCook | 4 | 5 | .19 | 118 |
| 3082 | Holdrege | 2 | 6 | .15 | 132 |
| 3043 | McCook | 5 | 5 | .17 | 122 |
| 3044 | McCook | 5 | 6 | .14 | 135 |
| 2961 | Wauneta | 5 | 6 | .17 | 123 |
| 3042 | McCook | 5 | 4 | .18 | 120 |
| 2960 | Wauneta | 5 | 5 | .20 | 112 |
| 3018 | McCook | 3 | 5 | .31 | 90 |
| 3062 | Holdrege | 1 | 5 | .16 | 127 |
| 3120 | Holdrege | 4 | 6 | .10 | 150 |
| 3139 | Holdrege | 5 | 5 | .15 | 133 |
| 3080 | Holdrege | 2 | 4 | .25 | 102 |
| 3234 | Hastings | 5 | 6 | .12 | 143 |
| 2880 | Wauneta | 1 | 6 | .18 | 121 |
| 3233 | Hastings | 5 | 5 | .13 | 142 |
| 3000 | McCook | 2 | 6 | .19 | 119 |
| 3158 | Hastings | 1 | 6 | .13 | 139 |
| 3196 | Hastings | 3 | 6 | .10 | 151 |
| 3101 | Holdrege | 3 | 6 | .20 | 113 |
| 3119 | Holdrege | 4 | 5 | .16 | 128 |
| 3194 | Hastings | 3 | 4 | .17 | 124 |
| 3195 | Hastings | 3 | 5 | .14 | 136 |
| 3155 | Hastings | 1 | 3 | .42 | 97 |
| 3157 | Hastings | 1 | 5 | .23 | 110 |
| 3140 | Holdrege | 5 | 6 | .13 | 140 |
| 3341 | Lincoln | 5 | 3 | .26 | 101 |
| 3287 | Lincoln | 2 | 3 | .13 | 141 |
| 3323 | Lincoln | 4 | 3 | .23 | 107 |
| 3269 | Lincoln | 1 | 3 | .17 | 125 |
| 3342 | Lincoln | 5 | 4 | .12 | 144 |
| 3419 | Weeping Water | 4 | 3 | .14 | 137 |
| 3305 | Lincoln | 3 | 3 | .11 | 147 |
| 3343 | Lincoln | 5 | 5 | .10 | 152 |
| 3290 | Lincoln | 2 | 6 | .07 | 163 |

| Soil Number | Area | Field | Depth | Humus, Per Cent | Rank |
|---|---|---|---|---|---|
| 3270 | Lincoln.............. | 1 | 4 | .09 | 155 |
| 3288 | Lincoln.............. | 2 | 4 | .08 | 159 |
| 3399 | Weeping Water....... | 3 | 3 | .15 | 134 |
| 3324 | Lincoln.............. | 4 | 4 | .12 | 145 |
| 3289 | Lincoln.............. | 2 | 5 | .05 | 170 |
| 3272 | Lincoln.............. | 1 | 6 | .05 | 171 |
| 3344 | Lincoln.............. | 5 | 6 | .09 | 156 |
| 3271 | Lincoln.............. | 1 | 5 | .04 | 175 |
| 3326 | Lincoln.............. | 4 | 6 | .06 | 165 |
| 3421½ | Weeping Water....... | 4 | 6 | .04 | 176 |
| 3400 | Weeping Water....... | 3 | 4 | .11 | 148 |
| 3325 | Lincoln.............. | 4 | 5 | .09 | 157 |
| 3439 | Weeping Water....... | 5 | 4 | .09 | 158 |
| 3361 | Weeping Water....... | 1 | 5 | .06 | 166 |
| 3438 | Weeping Water....... | 5 | 3 | .11 | 149 |
| 3401 | Weeping Water....... | 3 | 5 | .04 | 177 |
| 3360 | Weeping Water....... | 1 | 4 | .07 | 164 |
| 3362 | Weeping Water....... | 1 | 6 | .06 | 167 |
| 3380 | Weeping Water....... | 2 | 4 | .08 | 160 |
| 3440 | Weeping Water....... | 5 | 5 | .08 | 161 |
| 3359 | Weeping Water....... | 1 | 3 | .14 | 146 |
| 3381 | Weeping Water....... | 2 | 5 | .06 | 168 |
| 3306 | Lincoln.............. | 3 | 4 | .06 | 169 |
| 3379 | Weeping Water....... | 2 | 3 | .10 | 153 |
| 3420 | Weeping Water....... | 4 | 4 | .10 | 154 |
| 3308 | Lincoln.............. | 3 | 6 | .05 | 172 |
| 3421 | Weeping Water....... | 4 | 5 | .08 | 162 |
| 3402 | Weeping Water....... | 3 | 6 | .04 | 178 |
| 3307 | Lincoln.............. | 3 | 5 | .05 | 173 |
| 3382 | Weeping Water....... | 2 | 6 | .05 | 174 |
| 3441 | Weeping Water....... | 5 | 6 | .04 | 179 |

The humus extracts from the soils of the transition series gave better results when examined colorimetrically than did the soils themselves. This, of course, is due to the fact that in the extracts only humus is present; all other foreign matter which would affect the color has been eliminated. The solutions were first examined simply by placing the containers before a white background, and estimating the humus content by comparison with a known standard. An attempt was made, as was done in the case of the soil samples in the porcelain dishes, to arrange all of the solutions in the order of depth of color, beginning with the lightest one. They were then examined in the colorimeter, as previously described. The following table shows the results of both operations, and it is readily seen that the solutions may be

TABLE XV. ARRANGEMENT OF HUMUS EXTRACTS OF THE TRANSITION SOILS ACCORDING TO COLOR OF SOLUTIONS IN FLASKS

| Order of Arrange-ment | Per Cent Humus by Colorimeter | Order of Arrange-ment | Per Cent Humus by Colorimeter | Order of Arrange-ment | Per Cent Humus by Colorimeter |
|---|---|---|---|---|---|
| 1 | .04 | 49 | .16 | 97 | .39 |
| 2 | .04 | 50 | .15 | 98 | .44 |
| 3 | .04 | 51 | .15 | 99 | .40 |
| 4 | .04 | 52 | .13 | 100 | .40 |
| 5 | .04 | 53 | .13 | 101 | .40 |
| 6 | .05 | 54 | .16 | 102 | .39 |
| 7 | .05 | 55 | .18 | 103 | .37 |
| 8 | .05 | 56 | .15 | 104 | .42 |
| 9 | .05 | 57 | .23 | 105 | .45 |
| 10 | .05 | 58 | .22 | 106 | .50 |
| 11 | .06 | 59 | .18 | 107 | .39 |
| 12 | .06 | 60 | .17 | 108 | .44 |
| 13 | .06 | 61 | .20 | 109 | .61 |
| 14 | .06 | 62 | .26 | 110 | .56 |
| 15 | .06 | 63 | .17 | 111 | .52 |
| 16 | .07 | 64 | .19 | 112 | .56 |
| 17 | .08 | 65 | .19 | 113 | .58 |
| 18 | .08 | 66 | .24 | 114 | .64 |
| 19 | .08 | 67 | .19 | 115 | .72 |
| 20 | .09 | 68 | .20 | 116 | .70 |
| 21 | .09 | 69 | .26 | 117 | .78 |
| 22 | .07 | 70 | .24 | 118 | .58 |
| 23 | .08 | 71 | .16 | 119 | .70 |
| 24 | .09 | 72 | .19 | 120 | .72 |
| 25 | .10 | 73 | .19 | 121 | .74 |
| 26 | .10 | 74 | .19 | 122 | .66 |
| 27 | .11 | 75 | .22 | 123 | .74 |
| 28 | .10 | 76 | .23 | 124 | .82 |
| 29 | .11 | 77 | .25 | 125 | .87 |
| 30 | .13 | 78 | .23 | 126 | .84 |
| 31 | .09 | 79 | .22 | 127 | .70 |
| 32 | .11 | 80 | .24 | 128 | .78 |
| 33 | .15 | 81 | .30 | 129 | .74 |
| 34 | .12 | 82 | .26 | 130 | .70 |
| 35 | .14 | 83 | .28 | 131 | .82 |
| 36 | .17 | 84 | .21 | 132 | .93 |
| 37 | .10 | 85 | .29 | 133 | .78 |
| 38 | .10 | 86 | .26 | 134 | .82 |
| 39 | .12 | 87 | .30 | 135 | 1.00 |
| 40 | .13 | 88 | .31 | 136 | .93 |
| 41 | .12 | 89 | .31 | 137 | .82 |
| 42 | .13 | 90 | .33 | 138 | .87 |
| 43 | .14 | 91 | .38 | 139 | .82 |
| 44 | .14 | 92 | .36 | 140 | .87 |
| 45 | .15 | 93 | .36 | 141 | .82 |
| 46 | .15 | 94 | .31 | 142 | .87 |
| 47 | .14 | 95 | .33 | 143 | 1.08 |
| 48 | .17 | 96 | .34 | 144 | 1.00 |

| Order of Arrangement | Per Cent Humus by Colorimeter | Order of Arrangement | Per Cent Humus by Colorimeter | Order of Arrangement | Per Cent Humus by Colorimeter |
|---|---|---|---|---|---|
| 145 | 1.00 | 157 | 1.17 | 169 | 1.40 |
| 146 | 1.17 | 158 | 1.04 | 170 | 1.55 |
| 147 | 1.00 | 159 | 1.48 | 171 | 2.55 |
| 148 | .93 | 160 | 1.55 | 172 | 2.33 |
| 149 | 1.08 | 161 | 1.33 | 173 | 2.15 |
| 150 | 1.17 | 162 | 1.40 | 174 | 2.55 |
| 151 | 1.08 | 163 | 1.65 | 175 | 2.33 |
| 152 | 1.17 | 164 | 2.00 | 176 | 2.55 |
| 153 | 1.04 | 165 | 2.15 | 177 | 2.00 |
| 154 | 1.17 | 166 | 1.75 | 178 | 2.15 |
| 155 | 1.00 | 167 | 1.48 | 179 | 2.33 |
| 156 | 1.00 | 168 | 1.26 | 180 | 2.15 |

arranged in a fairly satisfactory manner—much more so than the soils themselves.

Table No. XVI gives the humus content of the composites of the individual fields from the Transition series, as determined by the colorimeter, which has been previously described. The gravi-

TABLE XVI. COMPARISON OF GRAVIMETRIC AND COLORIMETRIC DETERMINATIONS OF HUMUS IN THE COMPOSITES

*Humus*

| Soil Number | Colorimetric Per Cent | Gravimetric Per Cent | Soil Number | Colorimetric Per Cent | Gravimetric Per Cent |
|---|---|---|---|---|---|
| 3480 | 2.53 | 2.43 | 3460 | .20 | .27 |
| 3486 | 2.20 | 2.40 | 3466 | .18 | .27 |
| 3468 | 2.03 | 1.69 | 3461 | .20 | .27 |
| 3474 | 1.75 | 1.63 | 3467 | .15 | .27 |
| 3456 | 1.13 | 1.04 | 3471 | .16 | .29 |
| 3468 | 1.13 | 1.06 | 3488 | .16 | .57 |
| 3469 | .87 | .71 | 3477 | .15 | .26 |
| 3487 | .66 | 1.08 | 3478 | .14 | .28 |
| 3458 | .56 | .48 | 3482 | .11 | .38 |
| 3475 | .60 | .62 | 3472 | .11 | .21 |
| 3463 | .58 | .48 | 3479 | .11 | .25 |
| 3481 | .60 | 1.03 | 3473 | .11 | .18 |
| 3459 | .38 | .34 | 3490 | .08 | .23 |
| 3457 | .35 | .37 | 3485 | .08 | .15 |
| 3464 | .36 | .36 | 3489 | .07 | .27 |
| 3470 | .34 | .33 | 3491 | .06 | .19 |
| 3465 | .24 | .32 | 3483 | .05 | .26 |
| 3476 | .23 | .37 | 3484 | .04 | .21 |

metric per cents are also shown, for comparison of the two methods. The colorimetric per cents are set down according to rank and the corresponding gravimetric results placed opposite.

The humus content of the individual fields as determined by the colorimeter has been shown in previous tables. In the tables on pages 11–33 of this thesis all of the humus per cents, except those of the first and second feet, are the results of the colorimetric method. Since gravimetric determinations were made only on the first and second foot samples Table No. XVII will

TABLE XVII. COMPARISON OF GRAVIMETRIC AND COLORIMETRIC HUMUS DETERMINATIONS ON INDIVIDUAL FIELDS

*Wauneta Area*

| | Field 1 | | Field 2 | | Field 3 | | Field 4 | | Field 5 | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Col. | Grav. | Col. | Grav. | Col. | Grav. | Col. | Grav. | Col. | Grav. |
| 1st ft... | 1.17 | .99 | 1.00 | 1.04 | 1.17 | 1.07 | 1.00 | .99 | 1.00 | 1.02 |
| 2d ft... | .87 | .65 | .78 | .61 | .87 | .72 | .93 | .67 | .74 | .64 |

*McCook Area*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft... | .93 | 1.12 | 1.48 | 1.27 | 1.17 | 1.15 | 1.08 | 1.15 | 1.00 | 1.04 |
| 2d ft... | .52 | .55 | 1.08 | .81 | .61 | .60 | .82 | .67 | .40 | .49 |

*Holdrege Area*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft... | 1.48 | 1.37 | 1.65 | 1.44 | 1.75 | 1.63 | 2.00 | 1.70 | 2.15 | 1.90 |
| 2d ft... | .78 | .69 | 1.04 | .79 | 1.33 | 1.01 | 1.17 | .95 | 1.17 | .93 |

*Hastings Area*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft... | 1.40 | 1.50 | 1.72 | 1.67 | 1.26 | 1.39 | 1.55 | 1.56 | 1.55 | 1.42 |
| 2d ft... | .82 | .85 | .99 | .92 | .82 | .84 | 1.00 | .91 | .82 | .79 |

*Lincoln Area*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft... | 2.55 | 2.30 | 2.55 | 2.22 | 2.15 | 2.19 | 2.33 | 2.27 | 2.33 | 2.34 |
| 2d ft... | .87 | 1.08 | .64 | .96 | .30 | .80 | .56 | .90 | .84 | 1.16 |

*Weeping Water Area*

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 1st ft... | 2.15 | 2.13 | 2.00 | 2.09 | 2.33 | 2.24 | 2.55 | 2.43 | 2.15 | 2.28 |
| 2d ft... | .70 | 1.18 | .72 | 1.30 | .72 | 1.08 | 1.40 | 1.65 | .78 | 1.27 |

show a comparison of these gravimetric results with colorimetric determinations made on the same soils. In the majority of cases, the results obtained by the different methods agree fairly well, while in many instances they are strikingly close together.

The photometric method, which has been previously described, was tried but very briefly on transition soils, with only indifferent success. It was tried only on the first foot samples of the composites. The photometric method is convenient only for dark solutions, and is not practical for soils containing less than 1.00 per cent humus. It is not only slower in operation than the colorimetric method, but its results did not agree nearly so well with those of the gravimetric method, as the accompanying table shows. In soils of comparatively high humus content, however, it will give a fair estimation of the amount of humus per cent, as Alway and Pinckney demonstrated when they examined a large number of soils by this method several years ago. In this method it seems especially desirable that the standard be from the same locality as the soil under examination. The following table shows the agreement of the photometric with the gravimetric results obtained from determinations on the first foot of the composites from the transition series.

TABLE XVIII. COMPARISON OF PHOTOMETRIC AND GRAVIMETRIC HUMUS DETERMINATIONS

| Soil Number | Photometric Per Cent | Gravimetric Per Cent | Soil Number | Photometric Per Cent | Gravimetric Per Cent |
|---|---|---|---|---|---|
| 3456 | 1.37 | 1.04 | 3474 | 1.88 | 1.63 |
| 3462 | 1.37 | 1.06 | 3480 | 2.76 | 2.38 |
| 3468 | 2.43 | 1.69 | 3486 | 2.68 | 2.32 |

Samples of first foot composites from Lincoln, Weeping Water, Hastings and Holdrege were extracted with 4 per cent ammonia by the Hilgard method and it took fourteen days for a complete extraction. Humus determinations were made both colorimetrically and gravimetrically and the results compared with the results using "Rather Method" extractions from the same soils. Gravimetrically, the results were fairly concordant, but colorimetrically the Hilgard solutions ran much higher than did the Rather solutions, this probably being due to the fact that the small amount of extremely fine clay which is carried through the filter in the Hilgard method renders the solution less transparent in the colorimeter. The following table is self-explanatory.

TABLE XIX. COMPARISON OF THE RESULTS OF DIFFERENT METHODS OF EXTRACTING HUMUS

| Composite Number | Area and Depth | Hilgard (Grav.) | Rather (Grav.) | Hilgard (Col.) | Rather (Col.) |
|---|---|---|---|---|---|
| 3486 | W. W. 1st ft. | 2.22 | 2.27 | 2.97 | 2.24 |
| 3486 | W. W. 1st ft. | 2.25 | 2.37 | 2.94 | 2.20 |
| 3480 | L. 1st ft. | 2.45 | 2.40 | 2.80 | 2.40 |
| 3480 | L. 1st ft. | 2.31 | 2.30 | 2.67 | 2.53 |
| 3474 | Hast. 1st ft. | 1.64 | 1.65 | 2.02 | 1.76 |
| 3474 | Hast. 1st ft. | 1.69 | 1.60 | 2.02 | 1.75 |
| 3468 | Hold. 1st ft. | 1.90 | 1.68 | 2.11 | 2.03 |
| 3468 | Hold. 1st ft. | 1.85 | 1.70 | 2.11 | 1.86 |

## CONCLUSIONS

1. The Rather method for the determination of humus is the most practical of all gravimetric methods tried, and seems to be the most accurate method for determining humus in the first and second feet of Nebraska loess soils.

2. Below the first and second feet, the colorimetric method is the most practical method.

3. For the determination of humus-nitrogen, the Alway-Bishop method seems to be the most satisfactory method as it combines accuracy with economy of time.

4. The humus content of the first two feet of the eastern loess soils in Nebraska is approximately twice that of the first two feet of the western loess soils.

5. On the other hand, the humus content of the fifth and sixth feet of the western soils is two or three times that of the eastern loess soils of the same depth.

6. The decrease of humus content with the depth of soil is therefore much more gradual in the case of the western loess soils than it is in the case of the eastern soils.

7. The humus-nitrogen ratio is slightly higher in the east than

in the west, although, on the whole, it is fairly constant throughout the loess region.

8. The nitrogen content of humus is slightly higher in the west than in the east, although it also is fairly constant throughout the entire loess area.

9. The so-called "humus ash," as determined by the Rather method, shows a tendency to run a trifle higher in the western soils than in the eastern.

10. With regard to the comparison of soil colors, and the relation of soil color to humus content, it is concluded that the color of the soil may be associated fairly closely with the humus content when the soils under inspection are from the same locality, but when soils of different localities are brought together the extreme differences in types of color, caused by substances other than humus, such as lime and iron, made a satisfactory and reliable comparison by this method impossible.

11. An arrangement with regard to color intensity, using the humus extract instead of the soils themselves, may be made with a fair degree of accuracy without the colorimeter.

12. The photometric determination of humus was attended with only indifferent success and did not give satisfactory results in the case of soils containing under one per cent of humus.

13. In preparing humus extracts for colorimetric determinations, solutions prepared by the Rather method give a clearer and more transparent solution than than do those prepared by the Hilgard method, due probably to the fact that a slight amount of clay is carried through the filter in using the Hilgard method.